90-06245//

Planting Conifers in the Spruce Woods, 1904-1979

The Spruce Woods Provincial Forest, in south-central Manitoba, is an island of the B.18a Mixedwood Forest Section within the B.16 Aspen — Oak Section (Rowe, 1972). The soils are sand, silt and gravel deposited by the old delta of the Assiniboine river where it entered glacial Lake Agassiz. The topography is gently rolling with extensive dune development in places. White spruce on the dry upland sites, aspen and bur oak on the fresh sites, grow in scattered groups within treeless grass-covered areas to give a park like forest appearance. Larch and black spruce occur on the wet lowland sites. Jack pine, a species adapted to dry upland sites, is not native to the area.

Bird (1927, 1930, 1961) believed that the valleys and north slopes of the hills were once heavily forested, but that frequent fires from the adjacent prairies had killed many trees and prevented the forest from advancing. However, Jameson (1956) found little evidence in the soil profiles of such extensive former forest cover.

Planting 1904-1929

From 1904 to 1929 the Federal Department of the Interior — Forestry Branch continued a planting program of native and non-native coniferous trees to determine what species and planting method would be most suited for the area. Scots pine, jack pine, lodgepole pine, white spruce, Norway spruce, and some caragana were planted. Plantations before 1927 were experimental. In the following years, they were part of a reforestation program by the Department of the Interior, and following 1929, by the Manitoba Department of Natural Resources — Forestry Branch.

Sixty-two plantations were established from 1904 to 1926 on 83 ha using 711 500 seedlings that included 163 500 refills (Jameson, 1956). Stock age was 1-0 to 4-0. About 66 ha were planted with 2-0, 3-0, or 4-0 seedlings; 5 ha with 2-2 or 3-3 transplants, and 12 ha with stock of unknown age. By 1929 ninety-two hectares had been planted with 765 000 seedlings (Table 1).

Most of the planting was done with a spade or planting iron in ploughed furrows. In some cases, there was no ground

preparation and seedlings were planted directly in young open poplar stands, grassland or ground-cedar patches. All plantations were established in the spring at spacing between 0.9 m x 0.9 m and 1.2 m x 1.2 m.

A 1952 survey of the 62 plantations found only 33 plantations on 47 ha. Jameson (1956) summarized the results:

1. Average survival in the plantations existing in 1952 was about 40 percent for jack pine, 35 percent for lodgepole pine, and 20 percent for Scots pine.

2. Norway spuce and white spruce were complete failures.

3. Drought and heat were the chief causes of mortality, and white spruce, Norway spruce, and Scots pine were the species most affected.

4. Rabbits, pocket gophers and competition from grass caused additional losses to all species.

5. Winter-kill caused mortality and damage in Scots pine and white spruce plantations. Damage and mortality to the other species from this cause were negligible.

6. Planting in furrows and in cedar mats were the most successful techniques, the former being preferable. Underplanting in poplar was a failure, primarily due to the higher incidence of rabbits.

7. Jack pine exhibits the best growth rate and form.

8. Survival, rate of growth and form in the Scots pine plantations are better where the stock originated from Swedish and German seed.

Planting 1930-1946

From 1930 to 1946, 3.7 million seedlings were planted in the Spruce Woods (Haig, 1957; Table 1). Planting stock was 2-1 and 2-2 age class. A large number of plantations were refilled in one or more years, with the same or different species, but no definite numbers were given.

In 1956 a survey was made on 56 plantations established between 1930 to 1946 on 240 ha. All seedlings were hand planted in ploughed furrows. Most planting was in the spring. Six plantations on 19 ha were established in the fall of 1943 and 1944.

Height and diameter of jack pine was generally superior to Scots pine. However, one 1930 Scots pine plantation had the same average height and a larger diameter than a comparable jack pine plantation.

By 1956 it was apparent that diameter increment was depressed by overcrowding due to initial high planting density. Haig (1957) suggested a mechanical non-commercial thinning to remove every third row to free the crown of each tree towards one side. A first commercial thinning could then possibly have been made at 30 to 35 years of age. In 1955 some 1938 jack pine and 1945-46 Scots pine plantations were thinned, the latter were sold as Christmas trees.

For future planting Haig suggested that: jack pine be favoured for reforestation; white spruce seed from local origin be collected and used to grow seedlings for planting; more experimental conifers be planted; planting should only be done in furrows.

Planting 1947-1979

From 1947 to 1979, 5.7 million seedlings were planted in the Spruce Woods on 2 286 ha (Table 1). Seventy-four percent of the seedlings were spring-planted. Machine planting began in 1948 and was used for 81% of the seedlings. These machines prepared a furrow with a front-mounted shear that turned the sod layer over to both sides. The seedling was planted in the centre of the furrow and tamped down with two rear-mounted packing wheels. In 1946-47 spacing within plantations was increased to about 2 m x 2 m. Stock age was 2-1 to 2-2 range.

After 1948 no lodgepole pine was planted. Tamarack (2 500 seedlings) was first planted in 1979. Blue spruce was planted in 1947 and the Black Hills spruce in 1967; 2 000 and 18 000 seedlings, respectively. Early plantation maps show that 0.1 ha of blue spruce were already planted in 1938. Hardwoods were first planted in 1976.

No systematic survey was taken on the 1947 to 1979 plantations and no long term survival percentages can be given. However, refill or replacement planting of failed coniferous plantations from 1947 to 1979 at 19% compares to a replacement rate of 21% for the 1904 to 1929 plantations and shows that the same problems still exist.

After one or two refills some of the more recent plantations still have numerous and large unstocked patches (Table 2). Plantations 1-75 and 2-75 replaced the first plantations established in 1905-07. These Scots pine plantations were logged in 1974. An earlier

1.4 ha Scots pine plantation established in 1904 was destroyed by fire in 1906.

The blue and Black Hills spruce plantings were failures. The 1976 hardwoods had a first year failure rate of 41%.

Silvicultural management and plantation protection 1964-1979

Silvicultural work since 1964 has consisted of thinning and pruning; clean-up and sanitation; girdling of overtopping hardwoods and herbiciding to release plantations and natural white spruce regeneration (Tables 3 and 4; Figs. 1, 2, 3, 4, and 5). Row thinning removed each tree in every second or fourth row. The objective of selective thinning was to leave a specified distance between crop trees.

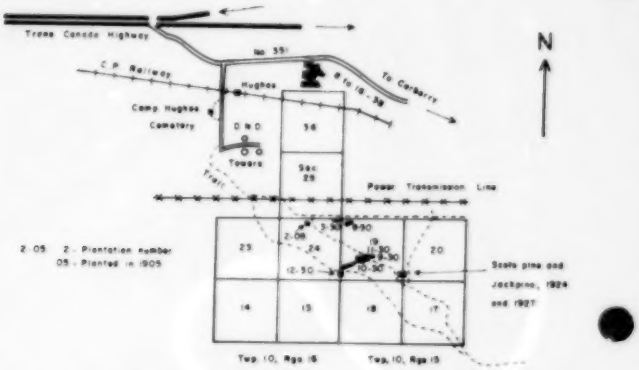

Figure 1. Access to jack pine and Scot's pine plantations south and east of old Camp Hughes.

Freezing rain and high winds caused damage to all of the 1943-46 jack and Scots pine plantations afer thinning (Fig. 4). In 1984 all damaged and windthrown trees were removed. After this work was completed freezing rain and wind caused more damage in the area and can be seen in jack pine plantations 2-43 to 4-43, 6-43, and 7-43 in the form of fallen and leaning trees not yet removed. Ice and wind damage, prior to and after 1984, was more severe in the jack pine than in the Scots pine.*

* *Personal communication with Peter Borowski, Manitoba Natural Resources, Forestry Branch.*

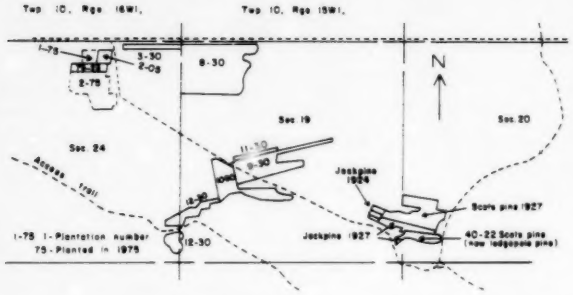

Figure 2. Jack pine and Scots pine plantations southeast of old Camp Hughes.

Scots pine plantation 6-46 was pruned. Jack pine plantation 5-46 is unspaced and unpruned. No windfall is present in the Scots pine, but light to moderate damage has occurred to the jack pine.

In 1969, jack pine and Scots pine plantations established in 1924 and 1927 (10 ha) were thinned by removing every fourth row (Fig. 2). In 1977 the 1927 plantations were selectively spaced. Usually, the middle row of the three rows and individual trees within the two remaining rows were removed. No windfall damage is present in the Scots pine but broken, fallen, and leaning trees occur in the jack pine.

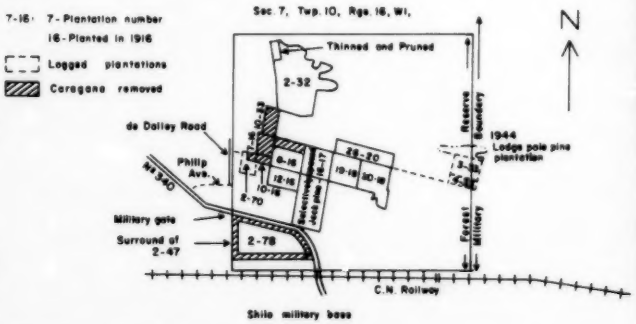

Figure 3. Pine plantations at Camp Shilo.

In 1953 and 1954 jack pine was planted in long, alternate, east to west 20 m wide strips (Fig. 4, Plantations 1-s-53, 2-s-53, and 2-s-54). In 1967 the vacant 20 m wide strips were planted to jack pine and some white spruce in plantation 2-s-54. In 1978-79 the 1953-54 plantations were selectively spaced and pruned. Windfall damage is present in the 1953-54 plantations in most strips and is most severe on the northern side exposed to the prevailing northwest winds. Damage in the 1967 strip plantations is negligible. Plantation 1-s-54 was planted to Scots pine in similar strips. No windfall damage has occurred to the Scots pine, but the strips were unspaced and unpruned.

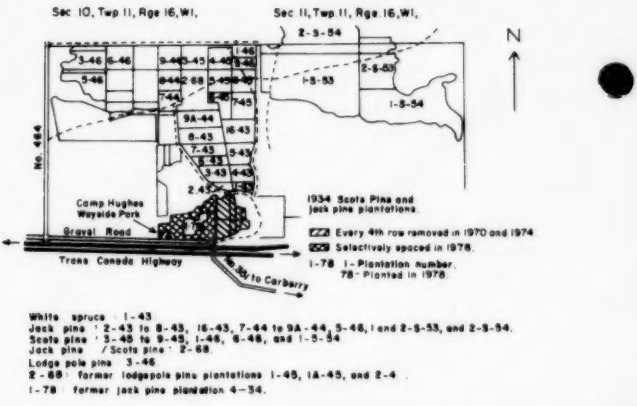
Sec 10, Twp 11, Rge 16, W1,
Sec 11, Twp 11, Rge 16, W1,
2-S-54
N
1-S-53
2-S-53
1-S-54
No. 484
Camp Hughes
Wayside Park
Gravel Road
Trans Canada Highway
To Sask to Carberry
1934 Scots Pine and jack pine plantations.
Every 4th row removed in 1970 and 1974
Selectively spaced in 1978.
1-78 1- Plantation number.
78- Planted in 1978
White spruce : 1-43
Jack pine : 2-43 to 8-43, 16-43, 7-44 to 9A-44, 3-46, 1 and 2-S-53, and 2-S-54.
Scots pine : 3-45 to 9-45, 1-46, 6-46, and 1-S-54
Jack pine / Scots pine : 2-68
Lodge pole pine 3-46
2-68 : former lodgepole pine plantations 1-45, 1A-45, and 2-4
1-78 former jack pine plantation 4-34.

Figure 4. Pine and spruce plantations adjacent to the Trans Canada Highway.

Caragana ingress that spread from earlier plantings that protected the former nursery headquarters and transplant beds and from jack pine plantation 10-16, where it was planted in alternate rows with the pine, was removed from 7 ha in 1978 (Fig. 3). Regrowth of the caragana has again taken place but it is present only as a shrub understorey in the mature plantations from which it was removed.

In 1972 and 1973 young jack pine, red pine, and white spruce plantations (102 ha) were protected from browsing by deer and snowshoe hares by spraying the seedlings with Arasan. Between 1967 and 1979 chemical and biological control of jack pine and spruce budworm was carried out on 6 866 ha.

No root collar weevils have been found in the Spruce Woods.* The absence of the weevil is attributed to the isolation of the Spruce Woods from natural jack pine.

Logging and volume of individual stands 1967-1989

Scots pine plantations established in 1905 to 1907 were clear cut in 1974 (Table 5). About one-half, or 1 ha of the 1905 plantation was left uncut and is available for viewing (Figs. 1 and 2, Table 6).

Scots pine plantation 26-20 was harvested in 1985 (Fig. 3). The trees in this plantation had very good form and a number were left standing on the area for cabin construction. Windfall within the residual stand was not a problem.

In 1967 a 3.6 ha buffer surrounding Scots pine plantation 2-47 was thinned and pruned (Fig. 3). During the 1970's, jack pine budworm caused severe damage to this plantation. Subsequently drought also affected the plantation. However, the treated buffer, with its healthy and free growing trees, was able to withstand the budworm attack and drought while the trees in the centre of the plantation were severely affected. In 1978 the centre of this plantation (7.3 ha) was salvage logged.

Lodgepole pine plantations 3-33 and 4-33 were reportedly performing well until winter drying damage occurred sometime in the mid 1970's (Fig. 3).* In the summer following the winter drying, jack pine budworm damage occurred. The two successive injuries within the same year caused high mortality and the plantations were salvage logged in 1979. A 1944 lodgepole pine plantation is located immediately adjacent to the north side of the former 1933 plantations and is available for viewing (Fig. 3).

In 1952 the Canadian Forestry Service established permanent sample plots in two Scots pine (8-16 and 12-16) and in two jack pine (7-16 and 20-18) plantations (Fig. 3). In 1947 portions of Scots pine plantation 12-16 and jack pine plantation 7-16 were selectively thinned and pruned. About 40% of the basal area was removed. In 1967 further selective thinning took place in portions of plantations 7-16, 8-16 and 12-16.

Results to 1964, prior to the 1967 thinnings, showed that Scots pine outperformed jack pine (Bella, 1967). Dominant heights of the two species were not significantly different but Scots pine had

* *Personal communication with Keith Knowles, Manitoba Natural Resources, Forestry Branch.*

significantly greater diameter increment and about 25% more basal area and volume production (Table 7). Thinning produced higher net increment and lower mortality for each species.

Current stand statistics and yield of a number of Scots pine and jack pine plantations are given in Table 6. Where Scots pine and jack pine are of equal age, diameter of the Scots pine is usually larger but height of the two species may be equivalent. Basal area and volume production of the Scots pine in some plantations is double that of the jack pine.

Discussion

Lodgepole pine, in spite of being a complete failure from 1930 to 1946 (Haig, 1957), should not be dismissed as being entirely unsuited to the Spruce Woods. An example of a poorly performing lodgepole pine plantation is identified in Figure 2. Scots pine plantation 40-22 was planted in grass and was a failure (Jameson, 1956). Subsequently, some lodgepole pine was planted on the area. Examples of other poorly performing lodgepole pine plantations are identified in Figure 3 (1944 plantation) and in Figure 4 (Plantation 3-46). Growth of the trees in these plantations has been slow, the stems are quite tapered, and foliage is very sparse with abnormally short needles, about 25 to 50 mm in length.

Lodgepole pine plantations 11-30 and 12-30 also were failures and dead seedlings were replaced with jack pine (Fig. 2). Presently there are numerous surviving lodgepole pine scattered throughout the two plantations. The crowns of these trees are fully developed, the foliage is healthy, and the needles are about 50 to 75 mm in length. The lodgepole pine have better form than the jack pine and larger diameters, but smaller heights. Eleven dominant trees of each species were measured throughout plantations 9-30 to 12-30 in July, 1989. Mean diameter and height of the lodgepole pine was 26.5 cm and 18.6 m; for jack pine it was 23.7 cm and 19.6 m.

The seeds produced by these lodgepole pine will almost certainly be hybrids of jack and lodgepole pine. But the performance of the lodgepole pine in comparison to the jack pine would justify a controlled pollination effort to produce a pure strain of lodgepole pine that is now well adapted to the Spruce Woods.

Scots pine is a more windfirm species than jack pine. A commercial logging operation within a 1920 Scots pine plantation at Camp Shilo left 186 mature stems/ha on the area, but no significant windfall damage has occurred. Thinning in jack pine that removed every second row or every fourth row, and then selectively spaced the remaining rows resulted in windfall damage. However, less damage occurred to the Scots pine when similarly treated. Jack pine should be planted in larger blocks rather than in

long, narrow strips. This would reduce the perimeter area and windfall damage on the northern side exposed to the prevailing wind.

Spacing in young but overly dense Scots pine has kept the trees vigorous and healthy. At Camp Shilo a 3.6 ha portion of a twenty-year-old Scots pine plantation was spaced and pruned in 1967. The trees in the treated portion were able to resist subsequent jack pine budworm attacks and drought that caused high mortality in 7.3 ha of the untreated area.

In view of the greater volume production of Scots pine, its windfirmness and response to thinning, it should be favoured over jack pine for reforestation purposes. Stands of good form are available to provide well adapted seed sources. However, both jack pine and Scots pine, in recent times, have proven to be difficult to regenerate in cut-over areas. Frequently one or two refill plantings have been required. Even so, recent surveys of ten to twenty-year-old jack pine and Scots pine found numerous and large understocked areas within the plantations.

Deer browsing is an important contributing factor in recent plantation failures. Browse damage today is greater than it was when the first plantations were established in the Spruce Woods, as whitetail deer populations have increased (Goulden, 1985), and the older established plantations now provide cover for the deer and more recent plantations forage material. In March, 1989 the Shilo and Trans Canada Highway plantations were visited while the area was still under 30 cm of snow. Numerous deer were seen in the area and there were well travelled paths between older plantations and recent plantings.

Scots pine and jack pine up to 1.5 m in height were severely damaged. Browsing removed lateral and terminal buds. On the taller saplings the terminal buds more frequently escaped browsing. One-year-old needles were a preferred food. Young seedlings just above the snow line had the terminals and upper laterals removed by browsing. Severe deformities and mortality will result.

The Spruce Woods Provincial Forest is an interesting and an attractive area widely used by the public. The jack pine and Scots pine are not native to the area and when planted in the present square and rectangular blocks in rolling terrain are not always attractive or aesthetically pleasing to the viewer. In the future, new plantations should be established to follow the local land contours and features. This would allow the plantations to satisfy both forestry and recreational purposes by blending into the landscape of natural and predominant white spruce, oak, and aspen.

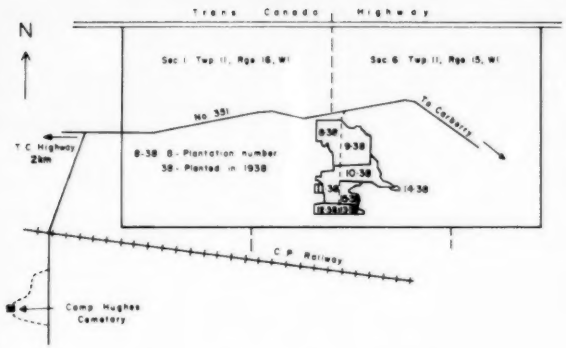

Figure 5. Jack pine plantations adjacent to Provincial Road No. 351.

References:

Bella, I.E. 1967. Development of jack pine and Scots pine in the Spruce Woods Forest Reserve, Manitoba. Can. Dep. For. and Rural Dev., For. Br., Dep. Pub. No. 1171.

Bird, R.D. 1927. A preliminary ecological survey of the district surrounding the entomological station at Treesbank, Manitoba. Ecology 8(2): 207-220.

Bird, R.D. 1930. Biotic communities of the Aspen Parkland of Central Canada. Ecology, 11(2): 356-442.

Bird, R.D. 1961. Ecology of the Aspen Parkland of Western Canada. Can., Dep. Agr., Res. Br., Pub. 1066.

Dom. For. Serv. 1948. Form-class volume tables. 2nd ed. Can. Dep. Mines and Resour.

Goulden, H. 1985. The White-tailed deer in Manitoba. Man. Nat. Resources.

Haig, R.A. 1957. Spruce Woods plantations, 1930-1946. Can. Dep. Nor. Aff. and Nat. Res., For. Br. Unpubl.

Jameson, J.S. 1956. Planting of conifers in the Spruce Woods Forest Reserve, Manitoba, 1904-1929. Can. Dep. Nor. Aff. and Nat. Res., For. Br., For. Res. Div., Tech. Note No. 28.

Rowe, J.S. 1972. Forest regions of Canada. Environ. Can., Can. For. Serv. Publ. 1300.

N.R. Walker
January, 1990.

TABLE 1. Percent distribution and survival of Spruce Woods planting 1904-1979

Years	Distribution and survival %	Scots pine	Jack pine	Lodgepole pine	Red pine	White spruce	Norway spruce	Other[1]	Hardwoods[2]	Total seedlings
1904-29	Distribution	38	27	4	0	31	<1	<1	0	764 948
	Survival	20	40	35	—	0	0	—	—	
1930-46	Distribution	16	74	8	1	1	0	0	0	3 749 052
	Survival	35	62	0	0	53	—	—	—	
1947-79	Distribution	26	58	0	1.5	12	0	1	1.5	5 700 380
	Survival	—[3]	—	—	—	—	—	—	—	

1 Caragana in 1916. Blue spruce in 1947. Black Hills spruce in 1967. Tamarack in 1979.

2 Beginning in 1976 (green ash, poplar, white birch, white elm, willow, dogwood shrubs, aspen, and Manitoba maple).

3 No data.

TABLE 2. Planting history of some Spruce Woods Plantations

Plantation	Area ha	Figure reference[1]	Species, season, and number planted		
			Planting date	Refill 1st	Refill 2nd
2-68	6.0	4	15 800 jP[2] Fall, 1968	5 000 jP 3 000 SP Spring, 1970	Nil
2-70	1.6	3	4 000 SP Spring, 1970	Nil	Nil
1-75 2-75	8.0	2	20 200 jP Spring, 1975	15 150 SP 2 000 rP Spring, 1978	10 000 SP Spring, 1979
1-78	1.5	4	4 600 jP 1 400 SP Spring, 1978	1 500 rP Spring, 1979	Nil
2-78	7.3	3	18 400 SP Spring, 1978	7 000 SP Spring, 1979	Nil

1 Figures 1 to 4.

2 jP — jack pine; SP — Scots pine; rP — red pine.

TABLE 3. Silvicultural activity in the Spruce Woods Provincial Forest 1964-1979

Activity	Area ha	Year	Remarks
Thinning			
Row	189.6	1966-74	Every 4th row removed in 167 ha jack pine and Scots pine and 5 ha unknown species. Second thinning of jack pine (17.6 ha) to remove centre of 3 rows.
Selective	112.4	1966-79	Scots pine 38 ha, jack pine 73 ha, and white spruce 1.4 ha.
Thinning and girdling	63.0	1964-65	Thinning of jack pine, Scots pine and some white spruce. Method unspecified. Girdling of overtopping aspen presumed.
Cleanup	8.5	1978	Remove dead Scots pine and jack pine (1934 plantations) attacked by budworm in 1976 and subsequently affected by drought (Fig. 4).
Cleanup	69.0	1977	Shoot borer attacked a 1970 jack pine and Scots pine plantation. Dead leaders and multiple stems were removed.
Pruning	30.0	1964-78	Jack pine, Scots pine, and white spruce. Usually done in combination with spacing.
Sanitation	81.0	1977	Dead material removed from a naturally regenerated white spruce area.
Sanitation	5.7	1972	All dead and dying trees were removed from some 1916-33 jack pine and Scots pine plantations.

Table 3 (continued)

Activity	Area ha	Year	Remarks
Caragana removal	7.0	1978	Caragana cleared from some 1916 and 1933 jack pine and Scots pine plantations (Fig. 3).
Girdling	662.0	1969-73	Aspen girdling to release natural white spruce regeneration.
Herbicliding	5.0	1977	Chemical release of a 1975 jack pine plantation.
Fertilization	0.6	1968 and 1977	Experimental tests.
Browse repellant	162.0	1972-73	Arasan applied on 1 to 6-year-old jack pine, red pine, and white spruce plantations.
Jack pine budworm control	3 141.0	1967-77	Chemical insecticide.
	25.0	1979	Biological.
White spruce budworm control	3 500.0	1973-75	Chemical insecticide.
	200.0	1973	Biological.

TABLE 4. Thinning history of some Spruce Woods Plantations

Plantation	Figure reference[1]	Remarks
Jack pine		
7-16	3	Selectively spaced in 1947 and 1967.
1924	2	Every 4th row removed in 1969.
1927	2	Every 4th row removed in 1969. Selectively spaced in 1977.
1934	4	Every 4th row removed in 1970-74. Portion selectively spaced in 1978.
8-38	5	Every 3rd row removed in 1955 and selectively spaced ca. 1969.
9-38	5	Every 4th row removed in 1967 and selectively spaced.
10-38	5	Every 4th row removed in 1967-69 and selectively spaced.
11-38	5	Every 4th row removed. North side has every 2nd row removed on a 20 m wide strip. Year of spacing unknown.
12,13,15-38	5	Every 4th row removed in 1969. Some selective spacing in 12 and 13-38.
2,3,4,5-43	4	Every 4th row removed in 1972. Middle of three rows removed in 1977.
6,7-43	4	Every 2nd row removed in 1977.
9-44	4	Every 4th row removed in 1979 and selectively spaced.
8,16-43 7,8,9A-44	4	Every 4th row removed and selectively spaced. A large part of 8-44 has every second row removed.

Table 4 (continued)

Plantation	Figure reference[1]	Remarks
1-2-S-53 2-S-54	4	Selectively spaced in 1978-79.
Scots pine		
2-05	2	Spaced in 1947.
8-16	3	Spaced in 1947 and 1967.
12-16	3	Spaced in 1947 and 1967.
1927	2	Every 4th row removed in 1969. Selectively spaced in 1977.
1934	4	Every 4th row removed in 1970-74. Selectively spaced in 1978. Originally planted to lodgepole and red pine; still some original survivors present.
3 to 9-45 1-46	4	Every 2nd row removed in 1955. Selectively spaced in 1979.
2-47	3	Surround of 20 to 30 m selectively spaced in 1967.
White spruce		
1-43	4	Every 2nd row removed in 1977. Selectively spaced in 1978.

[1] Figures 1 to 5.

TABLE 5. Area and age of logged plantations

Species	Planting yr.	Plantation no.	Logging yr.	Area ha	Age yr.	Volume* fbm	Reason for harvest
Scots pine	1905-07	2-05 3-06 4-07	1974 1974 1974	8.0	70 69 68	180 000	Overmature.
	1920	26-20	1985**	4.0	65	20 000	Commercial.
	1947	2-47	1978	7.3	32	—***	Jack pine budworm attack and drought.
Lodgepole pine	1916	9-16	1967	1.6	52	—	Poor performance.
	1933	3-33 4-33	1979	3.0	47	—	Winter drying and jack pine budworm attack.
	1945	1-45 1A-45 2-45	1967	6.0	23	—	Poor performance.
Jack pine	1934	4-34	1978	1.5	45	—	Jack pine budworm attack and drought.

* Volume figures from the Man. Dept. of Natural Resources — Forestry Branch.

** Commercial thinning.

*** No data.

TABLE 6. Current stand statistics for some Scots pine and jack pine plantations in the Spruce Woods (per ha values)

Plantation	Year	No. of trees	Mean diam.[1] cm	Mean ht.[2] m	Basal area m²	Volume Total[3] m³	Volume Merch.[4] m³	Silvicultural treatment
Scots pine								
2-05	1989[5]	789	27.4	21.2	46	423	374	Spaced in 1947.
	1952[6]	1 320	18.3	12.8	35	204	— [7]	
	1947	2 160	—	—	42	240	—	
8-16[8]	1988	1 557	22.1	19.8	60	517	440	Spaced in 1947 and 1967.
	1952	1 519	14.2	10.6	24	124	—	
	1947	1 552	—	—	25	125	—	
8-16[8]	1988	667	26.7	18.9	37	306	268	Spaced in 1947 and 1967.
26-20	1989	186	26.9	16.9	11	79	69	Spaced by commercial
	1952	944	13.7	10.0	14	68	—	logging in 1985.
1927	1989	775	25.6	19.4	40	344	300	Spaced in 1969 and 1977.
8-30	1989	733	26.4	21.5	41	379	333	Untreated.
6-46	1989	1 165	21.3	18.2	41	329	276	Pruned.
Jack pine								
7-16	1985	1 563	17.0	16.7	35	250	220	Spaced in 1947 and 1967.
	1952	2 002	11.4	8.2	21	86	—	

Table 6. Continued

Plantation	Year	No. of trees	Mean diam.[1] cm	Mean ht.[2] m	Basal area m^2	Volume Total[3] m^3	Volume Merch.[4] m^3	Silvicultural treatment
16-17[9]	1989	1 166	15.5	13.5	22	130	102	Spaced in 1985.
19-18[10]	1989	1 680	15.2	14.6	30	189	151	Untreated.
20-18	1985	822	21.6	20.3	30	223	208	Untreated.
	1952	890	14.5	10.0	15	70	—	
3-30	1989	1 094	19.3	18.0	32	241	222	Untreated.
5-46	1989	1 241	17.8	17.7	31	230	209	Untreated.

1 From mean basal area.
2 From height/diameter curve.
3 Table 67 for Scots pine and Table 28 for jack pine (Dom. For. Serv., 1948).
4 Table 69 for Scots pine and Table 30 for jack pine (Dom. For. Serv., 1948).
5 All 1985, 1988, and 1989 measurements were taken in the spring, except for 5-46 and 6-46 taken July 25.
6 1952 and 1947 values are taken from Jameson (1956).
7 No data.
8 Separate plots within the same plantation spaced to different intensities.
9 Originally planted to white spruce in 1917 and subsequently replaced with jack pine (ca 1930).
10 Originally sown to jack pine and white spruce in 1918 and subsequently planted with jack pine (ca 1930).

TABLE 7. Stand statistics for some Scots pine and jack pine plantations in the Spruce Woods (per ha values)[1]

Plantation	Year	No. of trees	Mean diam. cm	Mean ht. m	Basal area m^2	Volume Total m^3	Volume Merch. m^3
Scots pine							
8-16 (M.D.)[2]	1964	1 804	16.8	14.8	40	274	206
	1952	2 113	13.7	10.4	31	154	—[3]
12-16 (H.D.)	1964	2 735	15.7	14.5	48	320	222
	1952	3 427	12.2	9.8	39	189	—
12-16 (T.)[4]	1964	1 737	17.3	15.0	40	276	211
	1952	1 767	14.2	11.9	28	159	—
Jack pine							
20-18 (M.D.)	1964	1 717	15.7	14.5	33	231	172
	1952	1 878	13.2	9.8	26	119	—
7-16 (H.D.)	1964	2 982	12.7	13.2	37	238	133
	1952	4 250	10.2	9.4	35	163	—
7-16 (T.)[4]	1964	2 142	13.7	13.6	31	206	132
	1952	2 187	11.4	8.2	23	94	—

1 From Bella (1967).
2 M.D. — Medium density; H.D. — High density; T. — Thinned.
3 No data.
4 Thinned and pruned in 1947.